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(54) Electronic warning apparatus for rescue apparatus with high pressure gas tank

(57) The present invention relates to an electronic warning apparatus for rescue apparatus provided with high-pressure gas tank mainly for rescue apparatus used in mines working with pressurized oxygen to determine and indicate the gas quantity for the safe withdrawal from the area of the danger. The electronic warning apparatus is provided with a pressure sensor (1) emitting electrical signal attached to the gas tank, a signal processing unit (2) attached to the pressure sensor (1) and an operating unit (3) provided with operation mode switches (4, 5) for setting the actual operation mode, a light signal emitting unit (6) and/or a digital indicating unit (7) indicating the pressure of the stored gas.

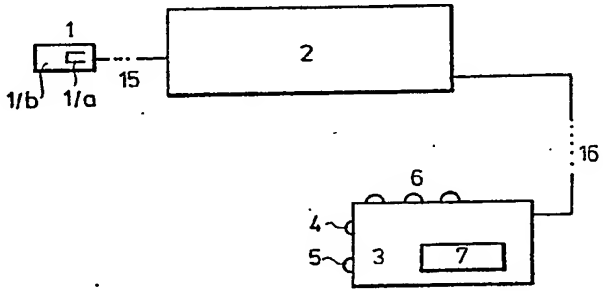

Fig. 1

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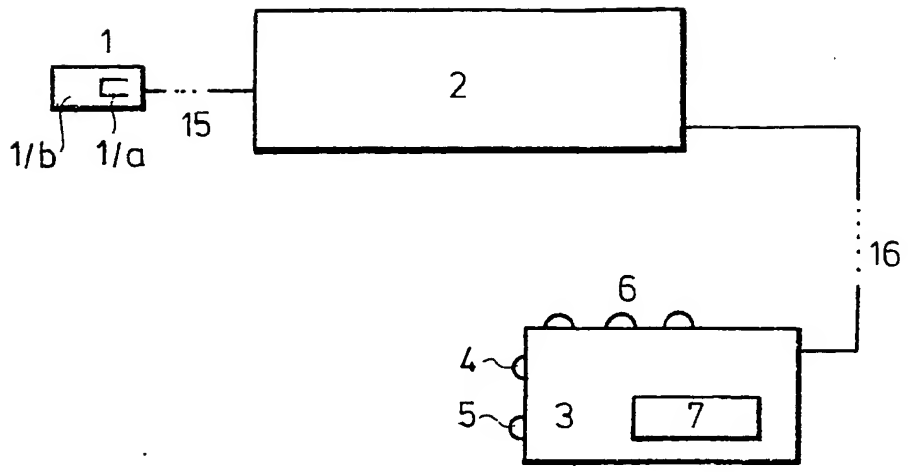

Fig.1

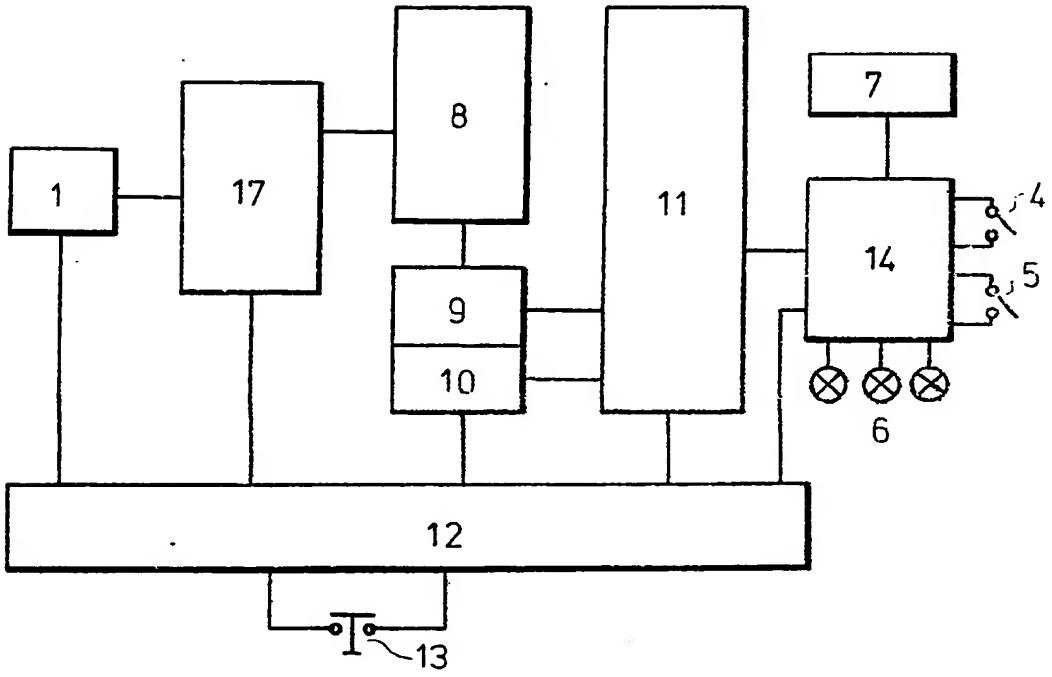

Fig.2

SPECIFICATION

Electronic warning apparatus for rescue apparatus with high pressure gas tank

The present invention relates to electronic warning apparatus for rescue apparatus provided with high-pressure gas tank mainly for rescue apparatus used in mines working with pressurized oxygen to determine and indicate the gas quantity for the safe withdrawal from the area of the danger.

The warning apparatus according to the invention is used not only in connection with the rescue apparatus employed in the field of mining, but in other fields too, where the continuous oxygen or air supply is possible only from the high-pressure gas tanks for the workers engaged in an area exposed to danger. Such area exists - apart from the mining - in certain sectors of the chemical industry, in the field of fire fighting and in several fields where the rescue activities or the continuous productive work are carried out in atmosphere cut off - at least temporarily - from the air, or in oxygen-deficient environment. Since the apparatus representing the subject of the invention is used mainly in the field of mining, the subsequent description deals with the details of the apparatus keeping in view the characteristic features of mining. This, however does not mean that the scope of invention is restricted only to the devices used in the field of mining.

It is known that the oxygen or air stored in high-pressure gas tank for the rescue apparatus used in mining is sufficient only for a period fixed in advance and it is connected through pressure reducing and gas control device to the mouth, nose, in short to the respiratory organ of the person concerned. The quantity of gas stored in the tank of the apparatus is sufficient for a limited period, consequently the amount of gas multiplied by a certain safety factor necessary to approach the area exposed to danger has to be available for the return as well. The mine safety regulations include in every case the safety factor with which the gas consumed during approach of the area of danger has to be multiplied, and when the amount of gas in the tank reaches the value of the gas volume multiplied with the safety factor, the withdrawal from the area of danger has to be commenced.

Since the tank capacity ensuring the oxygen-rich gas supply required for human sustenance during rescue activities or work and the temperature during consumption of the gas are regarded as practically constant, thus the pressure in the gas tank always represents definite information on the amount of gas in the gas tank. Consequently it is generally sufficient to measure the gas pressure in the tank and from its change conclusion can be drawn to the still available quantity of the gas.

In the known apparatuses a manometer was connected to the gas tank of the rescue apparatus - usually to the oxygen tank - and upon starting the approach of the area of danger, the value of the pressure had to be kept in mind. Upon reaching the work site or the location of rescue, the pressure of the gas in the tank had to be read off again. The amount of gas consumed during the period of access was determined from the difference between the value of the initial pressure and the instantaneous pressure shown upon arrival at the area of danger. This was multiplied with the specified safety factor - which meant three-times the amount, i.e. the safety factor was three according to the mining regulations - and when the gas pressure in the tank reached the quantity consumed during the access multiplied by the safety factor, then the withdrawal had to be commenced. This represented a heavy burden for the person carrying the rescue apparatus, because he had to calculate the amount of gas consumed during the time of access multiplied with the safety factor, then he had to check the manometer constantly for the pressure upon which the withdrawal from the work site had to be commenced. Considering that the conditions existing in the area of danger present an uncertain atmosphere for the persons working there, it is apparent that observation of the instruments and performing the various calculations presented a great deal of uncertainty, they imposed psychologically excess load on the persons, and occasionally a new emergency was brought about owing to the error committed under the extraordinary conditions.

The invention is aimed at the elimination of the above shortcoming of the known rescue apparatus and at relieving its user from counting and watching the varying values of the pressure. According to the aim of the invention the basic apparatus regarding its construction and weight should not be effected substantially by the change, and apart from this, it should give a clear indication for the user to recognize the pressure values and pressure ranges according to the operation modes.

According to the present invention the above aim is realized by the apparatus in that it has a pressure sensor attached to the gas tank emitting electric signal to a signal processing unit which is connected to an operating unit with the switches of which the respective operation modes can be set and accordingly the apparatus automatically calculates the pressure by multiplying the gas quantity consumed during the access with the required safety factor, upon which the withdrawal has to be commenced. This pressure and the instantaneous pressure value are indicated by a digital indicating unit on the operating unit. In addition, it emits light and/or sound signal for the operator or user of the apparatus when the pressure of the gas in the tank reahes the value which was fixed in advance by the signal processing unit as part of the apparatus, and upon which commencement of the withdrawal cannot be delayed. Apart from this, such light and/or sound signals are produced in the apparatus according to the invention which indicate the predetermined exhaustion of the supply unit used for operation of the apparatus. However, this state of exhaustion means that the area in the immediate vicinity of the location of danger is still accessible with adequate safety, where use of the rescue apparatus is no longer necessary. Thus the predetermined exhaustion condition producing the signal means that the inoperative condition of the apparatus will occur

only after a certain time fixed in advance.

Generally three operation modes can be engaged in the apparatus according to the invention, such as the approach operation mode, the work or rescue operation mode and the departure operation mode. Switching of these operation modes takes place with the possibly simplest multi-position switches in order to have a simple apparatus available for its users which does not require any special attention of the user. The signal processing unit of the apparatus according to the invention is built up of conventional elements commonly used in the field of the electronic data processing, signal and control units.

According to the present invention the apparatus is provided with a pressure sensor emitting electrical signal attached to the gas tank, a signal processing unit attached to the pressure sensor and an operating unit provided with operation mode switches for setting the actual operation mode, a light signal emitting unit and/or a digital indicating unit indicating the pressure of the stored gas.

According to a preferred construction of the apparatus the operating unit is a separate structural unit. This separate unit can be suspended on the belt of the operator or on the shoulder strap of the apparatus, thus the operator is able to keep in constant view or sense the light and/or sound signal of the operating unit, as well as the digital indicating unit.

According to a further possible construction of the apparatus the light signal emitting unit includes an element indicating the commencement of withdrawal from the area of danger and the predetermined exhaustion condition of the supply unit, which elements are preferably illuminating diodes.

Such construction may also come into consideration, where in addition to the light signal emitting unit indicating the mentioned two conditions, further light signal emitting units are also available. Thus for example such construction may also be considered which includes a permanently illuminating light signal emitting unit, preferably green illuminating diodes during normal operation.

The use of a memory unit is also preferable in the apparatus according to the invention which stores the information related to the consumed gas quantity multiplied with the safety factor, and this stored data is reckoned with when switching over or back into any operation mode.

The invention is described below in detail with reference to the accompanying drawings in which:

Figure 1 shows each assembly unit of the apparatus according to the present invention;

Figure 2 shows a possible construction of the apparatus according to the invention in the form of block diagram.

The diagram in Figure 1 illustrates a pressure sensor 1 attached to the oxygen tank of the rescue apparatus representing the basic apparatus, and this pressure sensor 1 emits an electric signal proportionate to the pressure. The resistance bridge 1/a of the pressure sensor 1 is embedded in silicon and/or ceramic etc. hard filling material 1/b, which is suitable to endure the high positive and negative accelerations against the high pressure, high temperature, impact and other dangerous factors of the medium to be measured, and it ensures the continuous perceptibility of the electric resistances. The signal emitted by the pressure sensor 1 is passed via a cable 15 to a signal/data processing unit 2 (designated by 11 in Figure 2). The unit 2 may be in the same casing as the basic apparatus or an additional unit fixed to the casing of the basic apparatus. It is in the unit 2 that the conversion and storage of the signals from the pressure sensor 1 take place, together with the performance of the required computations the storage in memory units 9, 10 mentioned below, and the generation of the appropriate control signals for an operating unit 3 (14 in Figure 2).

The operating unit 3 is expediently a discrete unit connected to unit 2 by a cable 16. The unit 3 is preferably attached to the body/apparel of the operator, e.g. affixed to his/her belt. Unit 3 contains operating mode switches 4,5 and light-emitting indicators 6, e.g. three in number, and a digital numerical display 7 which indicates the pressure prevailing in the oxygen tank/bottle.

In operation of the device according to the invention the gas pressure value for operator withdrawal is computed by automatically taking the predetermined safety factor into account. The signal amplifier 8 is connected to memory units 9 and 10 which in turn are connected to a data processing unit 11. The data processing unit 11 is connected to an operating unit 14 which actuates the digital indicating unit 7. The operating unit 14 includes the operation mode switches 4 and 5 and light signal emitting units 6. As shown in the block diagram of Figure 2 the elements of the apparatus are connected to the supply unit 12. The supply unit 12 is actuated with switch 13 or in case of inoperative condition it is advisable if this switch 13 actuated with magnetic field, i.e. the switch is arranged in a covered part of the apparatus suitably within the signal processing unit 2 shown in Figure 1. Namely its operation is more reliable here and it is not exposed to such effects which would detrimentally influence its safe operation. This is usually realized in such a way that the cover of the apparatus part incorporating the switch 13 is marked with a colour on the spot to which the magnet is approached in order to switch on and off the switch 13.

In order to demonstrate the operation of the apparatus, according to the invention, it is advisable to follow a numerical example. Let us assume that the safety factor used in mining is to be taken into account for operation of the apparatus. This safety factor - as mentioned earlier - is three. Let us assume furthermore that the apparatus according to the invention is used in connection with a rescue apparatus which has an oxygen tank in the basic apparatus and its starting pressure is 25 MPa. The pressure sensor 1 is connected to the oxygen tank of the basic apparatus, which emits an electric signal proportionate to the pressure in the tank for the signal processing unit 2. The signal processing unit 2 is fixed to the housing of the rescue apparatus. The operating unit 3 which comprises the operation mode switches 4 and 5, with the aid of which the

access operation mode, rescue and withdrawal operation modes can be engaged is fastened to the belt of the operator. The digital indicating unit 7 is on the operating unit 3 which indicates the existing pressure, or pressure range depending on the position of the operation mode switches. Naturally the pressure is in connection with the pressure of the oxygen tank, i.e. it indicates the pressure range available for the time of the rescue operation. The light signal emitting units 6 comprise three illuminating diodes in the case of the given example. One of the diodes emits green light, the second one red light and the third one yellow light.

Let us assume that the rescue apparatus is switched into the position corresponding to access operation mode with the operation mode switch 4. In this case 25 MPa pressure was indicated on the digital indicating unit 7, which corresponds to the starting pressure. Upon arriving at the area of danger, the operator switches the apparatus with the operation mode switch 4 into the position corresponding to the rescue operation mode. Upon switching over to rescue operation mode the apparatus with regard to the instantaneous pressure determines the differential pressure existing between the starting and instantaneous pressures. Let us assume that this differential pressure is 3 MPa. The apparatus multiplies this by three which means the earlier mentioned safety factor. Thus as a result of the starting pressure of 25 MPa and pressure drop 3 MPa taking place until the approach, 9 MPa is required to abandon safely the area of danger. In view of the fact that in the case of the given example 0.5 MPa is the basic pressure which determines the safe operation of the apparatus, it means that the withdrawal has to be commenced when the digital indicating unit indicates 9.5 MPa pressure in the oxygen tank. From this it follows that the range between 22 MPa pressure existing upon completion of the approach and the 9.5 MPa pressure required at the moment of commencing the withdrawal, i.e. the pressure range of 12.5 MPa can be used for the rescue activities.

The build-up of the processing unit 2 allows such position set with the operation mode switches 4 and 5, that for example the diode emitting green light is switched on permanently during the period of access, then this green light will be on even during the work or rescue operation mode until the pressure of the oxygen tank reaches 9.5 MPa required for commencement of the withdrawal. At this point of time the green light goes out and red light appears which gives instruction for the operator to commence the withdrawal. The operation mode switches 4 and 5 can be interconnected with such structural part, which switches on a second signal, too, simultaneously with the appearance of the red light, for example a horn or apparatus emitting sharp whistle which together with the red light calls the attention of the operator to begin the withdrawal.

An essential part of the apparatus according to the invention offers safety over the exhaustion time of the supply unit 12. This means that when the condition of the supply unit 12 reaches a certain value at which the power reserve is sufficient only for the safe withdrawal, it emits signal, e.g. through the yellow light of the diode of the digital light signal emitting unit 6 warning the operator for the withdrawal, who, in knowledge of the construction and operation of the apparatus recognize that the yellow light does not mean the reduction of the oxygen content below the required level, but it indicates such degree of exhaustion of the supply unit, at which the withdrawal has to be commenced.

The apparatus according to the invention - as it was demonstrated with the examples - makes the calculation related to the gas quantity and observation of the indicator instrument absolutely unnecessary for the user and thereby it relieves the operator of the apparatus from the mental burden or from the stress of the nervous system related to the calculation of the gas quantity required for the safe withdrawal.

On the basis of the described examples it can be established that the apparatus according to the present invention does not add much to the weight and capacity of the basic apparatus, consequently it does not effect the physical load of those participating in the rescue activities to any considerable extent.

Furthermore it was found on the basis of the described examples that the conversion of the signal emitted by the pressure sensor 1 of the apparatus according to the invention, the required calculations, their storage in the memory unit and working out the suitable control take place in the signal processing unit 2 for the operating unit 3. The suitable electric control power may actuate an electrical magnet valve too, in addition to the light and sound signal, which is capable to activate or deactivate further apparatuses. Consequently its further field of application includes tracking the pressure in the liquid or gas tanks, pipelines etc. under normal and extreme ambient conditions, as well as the control and alarm functions, actuated as transmitter as well as the control and alarm functions, actuated as transmitter as well.

A particular field of application is the process control (automation) in compliance with the safety and accident preventive aspects, including the automatic feed back of the results.

CLAIMS

1. Electronic warning apparatus for rescue apparatus provided with a high-pressure gas tank, e.g. for mine rescue apparatus operating with pressurized oxygen to determine and indicate the gas quantity for a safe operator withdrawal from a danger area, comprising a pressure transducer for sensing the pressure prevailing in said gas tank and emitting a functionally related electrical signal, a signal processing unit connected to the pressure transducer and an operating unit connected to said processing unit and provided with operation mode switches for setting the actual operation mode, and at least one visual and/or audio warning indication unit for indicating the pressure and/or quantity of the gas remaining in said tank.

2. Warning apparatus as claimed in claim 1, wherein the pressure transducer is provided with a

resistance bridge embedded in hard filling material in order to withstand high positive and negative accelerations.

3. Warning apparatus as claimed in claim 1 or 2, wherein the operating unit is a structural unit separate from the rest of the apparatus.

4. Warning apparatus as claimed in any preceding claim, wherein the visual warning indication includes means, preferably an LED, for indicating the beginning of the withdrawal from the area of the danger and the predetermined exhaustion condition of the power source for the apparatus.

5. Warning apparatus substantially as herein described with reference to and as shown in the accompanying drawing.

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